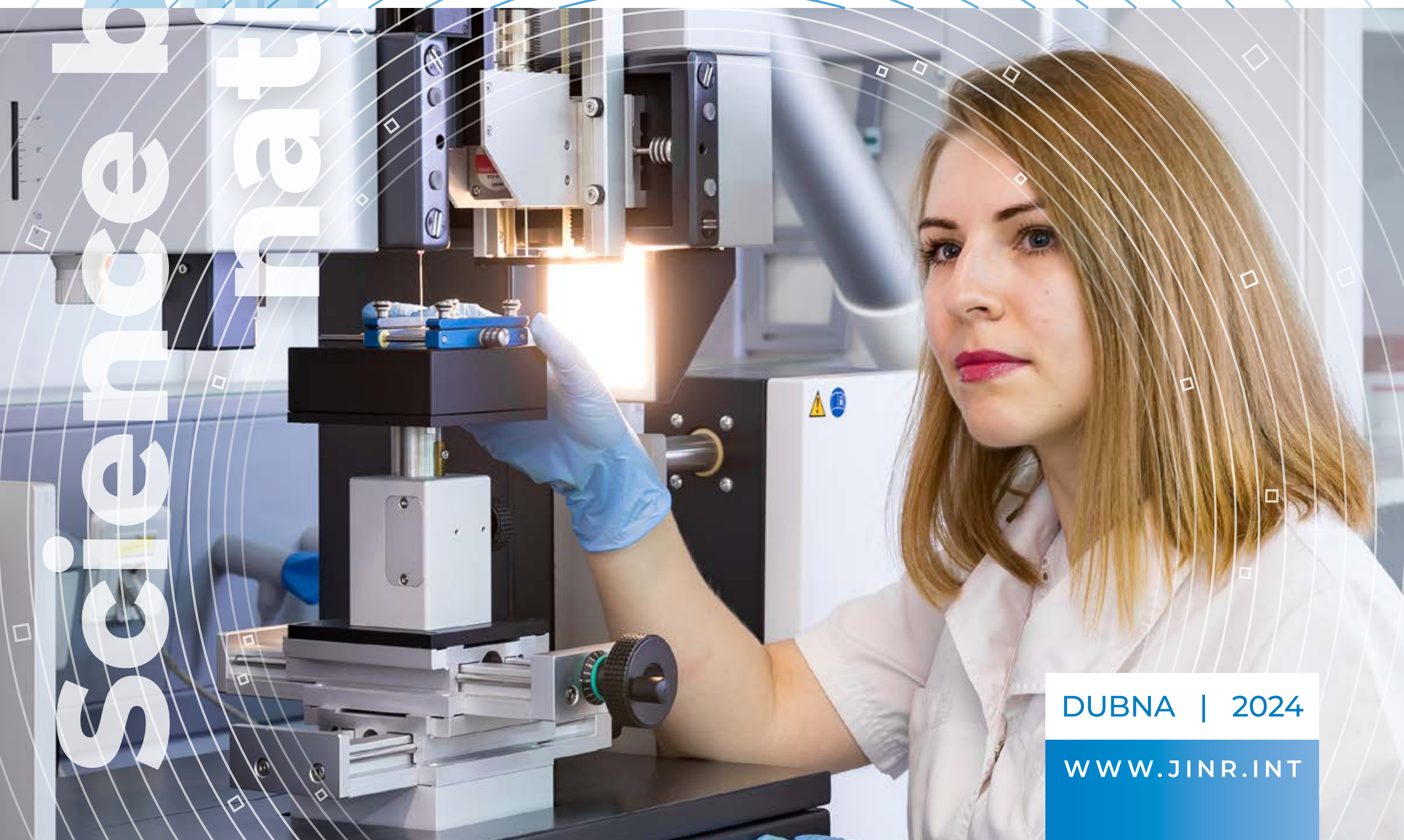
JOINT INSTITUTE FOR NUCLEAR RESEARCH

FLAGSHIP PROJECTS

science brings nations together



DUBNA | 2024

WWW.JINR.INT

THE JOINT INSTITUTE FOR NUCLEAR RESEARCH

is an international intergovernmental organization, a world-famous scientific centre that integrates fundamental theoretical and experimental research with the development and application of advanced technology and university education.

The megascience project on the construction of the superconducting heavy ion collider NICA is being implemented at the Joint Institute.

JINR plays a significant role in the implementation of the megascience project on the construction of the Baikal–GVD deep underwater neutrino telescope.

10 new elements have been discovered at JINR.

RESEARCH DIRECTIONS

Theoretical Physics

Relativistic Heavy Ion Physics

Spin Physics

Particle Physics

Low Energy Nuclear Physics

Neutron Nuclear Physics

Condensed Matter Physics

Neutrino & Astroparticle Physics

Life sciences: **Radiobiology**, **Biomedicine**, **Structural Biology**, **Astrobiology**, **Ecology**

IT & High-Performance Computing

Outreach & Education

7 JINR Laboratories, each being comparable with a large research institute in the scale of investigations performed

Frank Laboratory of Neutron Physics

flnph.jinr.ru

Veksler and Baldin Laboratory of High Energy Physics

lhep.jinr.ru

Flerov Laboratory of Nuclear Reactions

flerovlab.jinr.ru

Dzhelepov Laboratory of Nuclear Problems

dlnp.jinr.ru

Meshcheryakov Laboratory of Information Technologies

lit.jinr.ru

Bogoliubov Laboratory of Theoretical Physics

theor.jinr.ru

Laboratory of Radiation Biology

lrb.jinr.ru

Dear colleagues and friends,

The Joint Institute for Nuclear Research in Dubna is an integral part of a global family of unique international research centres. Our mission is to provide the highest quality of the scientific agenda for cutting edge research and discoveries aimed to understand the fundamental properties of matter.

The JINR Long-Term Development Strategy up to 2030 and beyond is designed to strengthen our common international scientific family. The core research fields at JINR are Low Energy Nuclear Physics, Relativistic Heavy Ion and Spin Physics, Particle Physics, Neutrino and Astroparticle Physics, Condensed Matter and Neutron Nuclear Physics, Radiobiology and Nuclear Medicine, Theoretical Physics, Information Technologies & High-Performance Computing. The foundation of the Institute is its world recognised scientific schools. Development of the idea of neutrino oscillations, synthesis of new superheavy elements, ultracold neutrons, superfluidity of the nuclear matter, postradiation recovery of cells, quantum field theory, harmonical superdimension in supersymmetry, a new generation of neutron pulsed reactors, and hyper convergent heterogeneous computing cluster — these are only some of visible scientific subjects associated with modern JINR.

Our Institute and its laboratories are also setting the agenda at the forefront of innovations. To name just a few of these frontiers: novel materials and energetics, biomedicine, quantum technologies, data science, etc.

JINR is of course about basic science. No doubt that the quality of our scientific product is mainstaying on essential issues reinforcing us as a modern dynamic international intergovernmental scientific organization: worldwide scientific cooperation, science diplomacy, friendly social environment, digitalisation, innovation policy.

Our international team is diverse but united through the passion for research and sharing the value of international cooperation. The JINR Sofia Declaration signed in November 2021 highlights the value of international scientific and technological integration in solving the tasks of strengthening peace, mutual understanding, and socio-economic progress of all the countries.

JINR is open to attracting new partners and even entire regional clusters: science brings nations together. We feel obligated to use our scientific and integrating potential to promote peaceful scientific and technological progress in different parts of our planet.

Please, enjoy this brochure and become our missionary. On behalf of the JINR team I wish you pleasant acquaintance with our International Research Centre.

Grigory Trubnikov

Director of JINR

Seven-Year Plan for JINR Development (PDF)

JINR Strategy (PDF)

ORGANIZATION

The Committee of Plenipotentiaries of the Governments of the JINR Member States (CP), which is the supreme governing body of JINR, takes main decisions on the Institute's activities. The JINR Member States share the financing of the JINR activities and have equal rights in controlling the Institute. The Member States make contributions in the amount established by the Committee of Plenipotentiaries. The Finance Committee and the Scientific Council operate under the CP JINR.

The research policy of JINR is determined by the Scientific Council. It consists of eminent scientists from world-leading scientific organizations and universities.

The Programme Advisory Committees (PACs) are advisory bodies to the JINR Directorate and to the JINR Scientific Council in three scientific fields: Particle Physics, Nuclear Physics, Condensed Matter Physics. The Programme Advisory Committees evaluate experimental projects proposed by scientific collaborations, institutes, JINR laboratories, and individual scientists.

The Science and Technology Council of the Institute is an advisory body to the Directorate of the Institute. It aims to ensure the participation of the scientific staff of the Institute in organizing its research activities. The immediate control over the JINR activity is exercised by the Directorate.

MISSION AND GOALS

The Institute was established with the aim of uniting the efforts, scientific and material potential of its Member States for investigations of the fundamental properties of matter. Over almost 70 years, JINR has accomplished a wide range of research and trained scientific staff of the highest quality for the Member States.

The concept of further development of JINR as a multidisciplinary international centre for fundamental research in nuclear physics and related fields of science and technology implies efficient use of theoretical and experimental results, as well as methods and applied research at JINR in the field of high technology through their application in industrial, medical, and other kinds of technical development. The Institute's development strategy is detailed in the Seven-Year Plan for the Development of JINR.

JINR IS A MEMBER OF 39 COLLABORATIONS AT SCIENTIFIC CENTRES AROUND THE WORLD

>900 PARTNER NETWORK ORGANIZATIONS

On 1 February 1957, JINR was registered by the United Nations.

On 24 September 1997, UNESCO and JINR signed an Agreement on Cooperation in Paris. Based on the agreement, the Institute became one of the international intergovernmental organizations associated with UNESCO.

JINR DOSCIENCE@DUBNA

INTERNATIONAL DIALOGUE FOR SCIENTIFIC INTEGRATION AND SCIENCE DIPLOMACY

SOFIA DECLARATION

The Declaration highlights the value of international scientific and technological integration in solving the tasks of strengthening peace, mutual understanding, and socio-economic progress of all the countries. The document was adopted on 22 November 2021, at the session of the Committee of Plenipotentiaries of the Governments of the JINR Member States held in Bulgaria.

Full text

JINR'S RANK
in the worldwide rating of **International Intergovernmental Research Organizations**

2 PERSONNEL

5 BUDGET natural science only

8 BUDGET

The list of the Intergovernmental Research Organizations is received from the open database of the Yearbook of International Organizations. Information on budget and staff is taken from the annual reports of the organizations.

JINR FLAGSHIP PROJECTS

NICA: Nuclotron-based Ion Collider fAcility

SEARCH FOR NEW STATES OF NUCLEAR MATTER

Megascience project for research into the critical states of nuclear matter under extreme conditions, which occurred after the Big Bang at early stages of the Universe evolution using high-intensity heavy ion beams.

nica.jinr.ru

NICA PARAMETERS

Range of nuclei:
from hydrogen to bismuth, including gold

Extracted beams:
energy — up to **4.5 GeV/nucleon**
intensity —
5·10^{8} s^{-1} for heavy ions
10^{10} s^{-1} for protons

Designed luminosity:
10^{27} cm^{-2} s^{-1} for heavy ions
10^{32} cm^{-2} s^{-1} for light nuclei and polarised protons as well as deuterons

NICA covers an energy range where most important and interesting physics appears to take place — transition from hadronic to partonic effect dominance, possible appearance of first order phase transition in QCD phase diagram, transition from baryon to meson dominance in particle production.

Energy
$\sqrt{S}$=4–11
GeV/nucleon

Collider ring circumference
503m

APPLIED RESEARCH INFRASTRUCTURE FOR ADVANCED DEVELOPMENTS AT NICA FACILITY

Channels for transporting charged particle beams and irradiation stations are being developed and put into operation at NICA:

SOChI: Station Of Chip Irradiation (already operational),

ISCRA: Irradiation Station of Components of Radioelectronic Apparatus,

SIMBO: Station of Investigation of Medico-Biological Objects,

SHINE: Station of High Energy Investigation in Nuclear Energetics.

They are designed for research in the fields of life sciences, radiation materials science and radiation resistance of electronics, development of advanced technologies for nuclear power problems.

The NICA Accelerator Complex is a project allowing young specialists to join an ambitious scientific challenge. This unique research infrastructure is a magnet for talented youth from all the regions of the JINR location country — Russia — and other countries of the world.

NICA provides young people with a great opportunity to build successful careers in science and make the most of their potential, being members of the multinational team working at the forefront of science.

100%

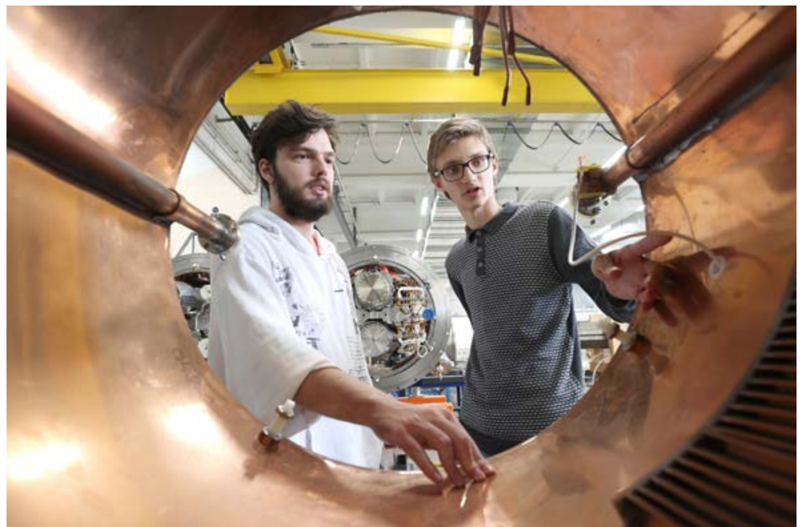
of **dipole** and **quadrupole magnets** manufactured and tested for the project

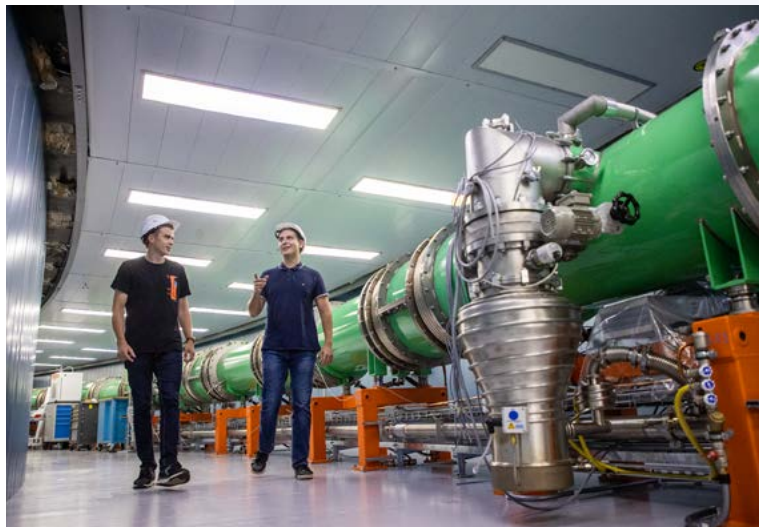
99%

capital construction

88%

overall project progress

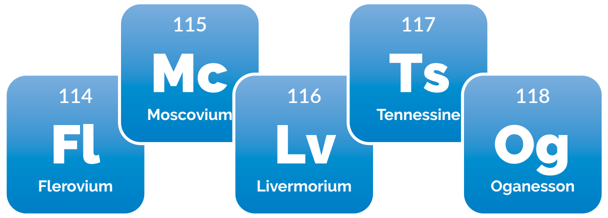




Synthesis of superheavy elements

JINR conducts advanced experiments on the synthesis of new superheavy elements.

The scientific programme includes experiments on the study of nuclear and chemical properties of new superheavy elements, reactions of fission, fusion, and multinucleon transfer in heavy ion collisions.



5 NEW superheavy elements have been discovered at JINR that conclude period 7 **of the Periodic Table**

for the past 25 years

AT PRESENT

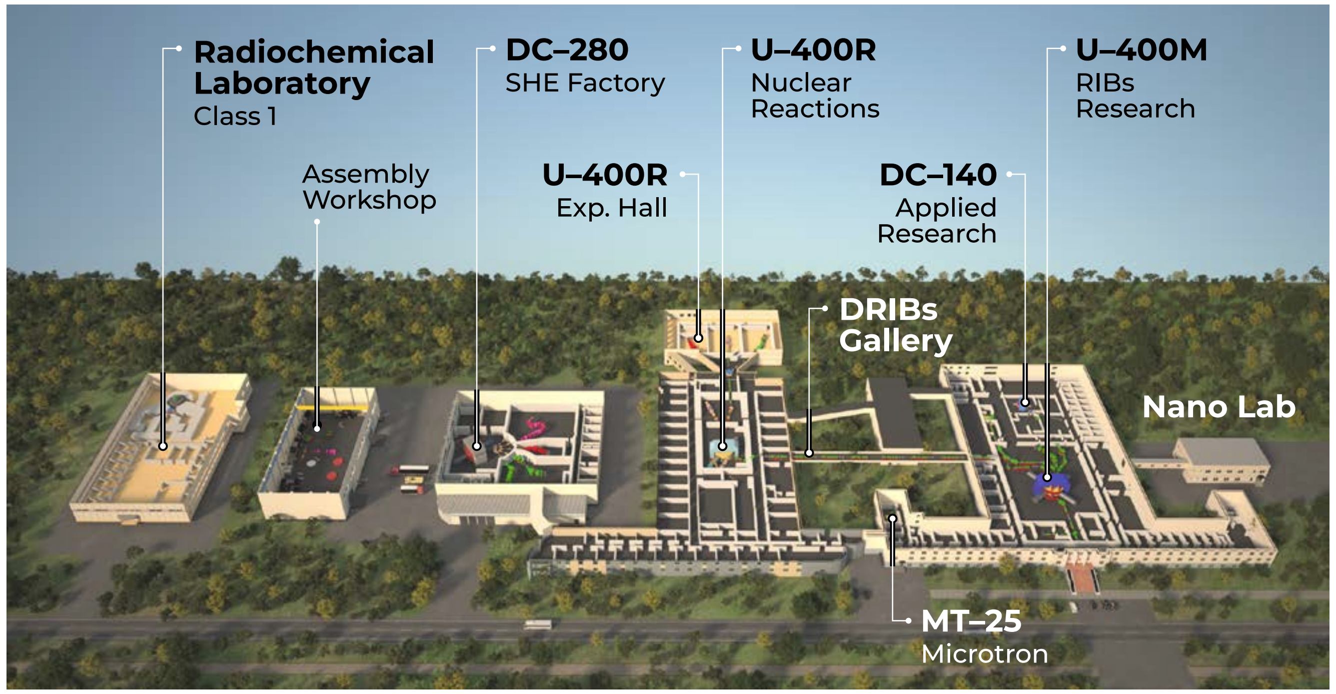
The development of works in the fields of synthesis and property study of superheavy elements is associated with the creation of a new accelerator complex called the Superheavy Element Factory (SHE Factory) based on the DC–280 specialised cyclotron. The key task of the complex is to synthesise new chemical elements with atomic numbers 119, 120, and further, as well as to study in detail nuclear and chemical properties of the earlier synthesised superheavy elements.

Record parameters of accelerated heavy ion beams have been achieved at the Superheavy Element Factory accelerator complex. The ^{48}Ca beam intensity exceeds 8 pμA. The ^{40}Ar beam at the SHE Factory has reached its designed intensity of 10 pμA.

The scientific infrastructure of the SHE Factory is gradually improving: accelerators U–400 and U–400M are developing, a new facility DC–140 is under construction for applied research in the fields of track membranes and materials science.

One of the results of global importance achieved by JINR scientists is the experimental proof of the existence of the "island of stability" of superheavy elements centred near Z=114 and N=184.

In November 2021, FLNR JINR Scientific Leader **Yuri OGANESSIAN**, who had new element 118 named after him for his pioneering contributions to transactinide elements research, was awarded the UNESCO–Russia Mendeleev International Prize in the Basic Sciences ***"to acknowledge his breakthrough discoveries extending the Periodic Table and for his promotion of the basic sciences for development at the global scale."***



BASIC FACILITY — DRIBs–III ACCELERATOR COMPLEX

SUPERHEAVY ELEMENT Factory

Strategic Research Directions:

- Heavy and superheavy nuclei
- Light exotic nuclei
- Radiation effects and nanotechnologies
- Accelerator technologies

SUMMARY OF EXPERIMENTS:
2020–2024

~250 new events of synthesis of superheavy nuclides

VS. ~100 events at all the facilities in the world, including in Dubna, since 1999

42 isotopes decays were studied

7 new isotopes were discovered:
^{288}Lv, ^{286}Mc, ^{276}Ds, ^{275}Ds, ^{272}Hs, ^{268}Sg, ^{264}Lr

New decay modes:
^{268}Db (alpha decay)
^{279}Rg (spontaneous fission)

Test of target stability up to
8 pμA ^{48}Ca

Baikal–GVD

Baikal–GVD — deep underwater cubic-kilometre scale neutrino telescope — is an international megascience project in the fields of neutrino physics and astrophysics.

The Neutrino Telescope Baikal–GVD is located in Lake Baikal 3.6 km away from the shore, at a depth of about 1,300 m. Baikal–GVD is the largest in the Northern Hemisphere and the second in size in the world.

Baikal–GVD: Identification of astrophysical sources of ultra-high energy (exceeding tens of TeV) neutrinos.

Topicality: their sources are still unknown. The identification of sources will help to elucidate the mechanisms of galaxies creation and evolution. This unique scientific facility is an important tool of multi-messenger astronomy, a new powerful method to investigate the Universe.

Baikal–GVD is one of the three neutrino telescopes across the world and, along with IceCube at the South Pole and KM3NeT (former ANTARES) in the Mediterranean Sea, is part of the Global Neutrino Network (**GNN**).

The Baikal–GVD Neutrino Telescope is being constructed by the international collaboration with a leading role of the RAS Institute for Nuclear Research (Moscow) and the Joint Institute for Nuclear Research.

more than **60** scientists & engineers

from **9** international research centres

AT PRESENT

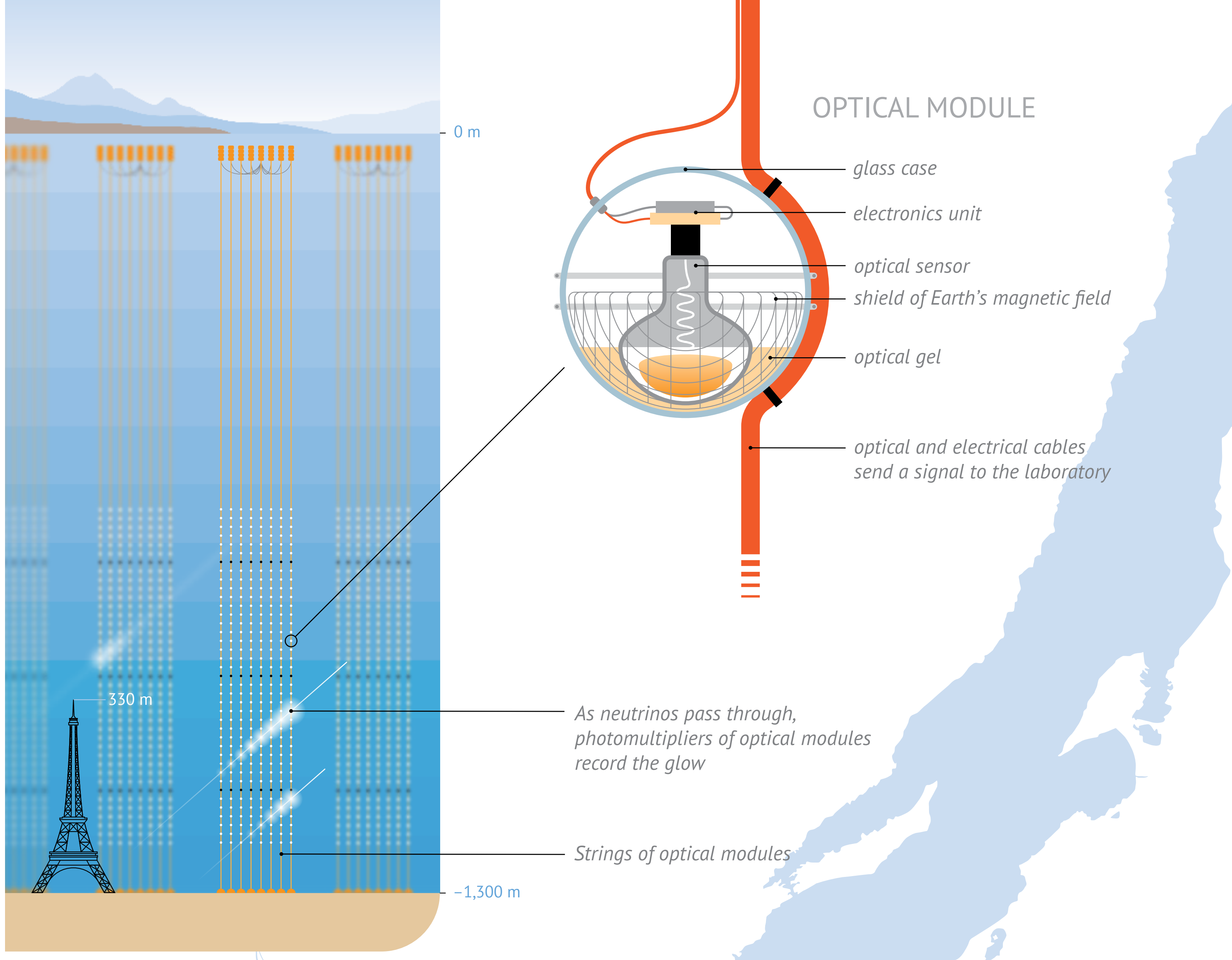
During the last Baikal expedition 2023, the collaboration of the project installed one new cluster of the neutrino telescope. All 13 installed clusters are now registering events.

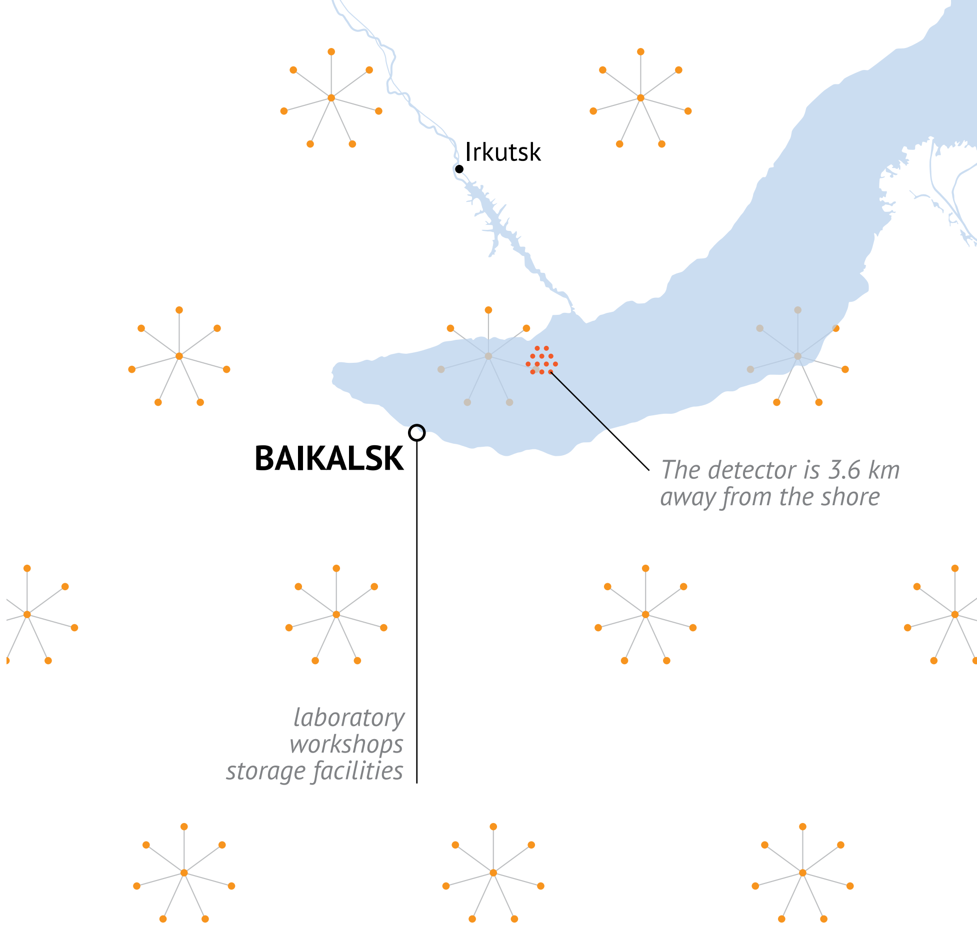
INSTALLED	in 2024	total
Clusters	1	13
Optical modules	576	4,104
Optical + acoustic cables, km	84	584
High-voltage bottom cables, km	15	105

In December 2021, the IceCube Neutrino Observatory at the South Pole announced the observation of a candidate astrophysical neutrino track with an estimated energy of about 172 TeV. Four hours later, an interaction of another neutrino coming in from the same direction with an estimated energy of 43 TeV was found in the Baikal–GVD data.

Together, **Baikal–GVD and TAIGA** can provide a unique **multi-messenger observation** of the Universe integrated into the global astroparticle network.

baikalgvd.jinr.ru





FLAGSHIP PROJECTS

International Intergovernmental Organization
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